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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 1041

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. ▼ January 11, 1922

A STUDY OF SWEET-POTATO VARIETIES WITH SPECIAL REFERENCE TO THEIR CANNING QUALITY

By

C. A. MAGOON and C. W. CULPEPPER
Office of Horticultural and Pomological Investigations

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INTRODUCTION.

To the people of the Southern States the sweet potato constitutes one of the most important food crops. Owing, however, to its highly perishable nature in the raw state, the shipment of this crop to distant markets is attended with considerable risk. The introduction of modern methods of preservation is overcoming some of these difficulties, and the sweet potato is rapidly coming into its own as an important addition to the dietary of the American people, North as well as South. In 1917 the total pack of canned sweet potatoes, according to figures compiled by the United States Food Administration, amounted to 238,250 cases of cans of all sizes; in 1920 the pack, according to the best figures obtainable, was 473,384 cases (all sizes being reduced to No. 3 cans).

For a number of reasons it is important that the canning of sweet potatoes and the wider use of the product by the housewife should be encouraged. The sweet potato, as shown by analysis and by the experience of its users, is very high in food value; it is adapted to a wide variety of culinary uses; and a greater market for the canned product only awaits development.

The sweet potato (*Ipomoea batatas*) belongs to the same family botanically as the common morning-glory (Convolvulaceæ). Although it frequently blossoms and even produces seed in the extreme southern portions of our country, propagation as practiced is not by the use of seed but of slips and vine cuttings which are set in the field.

In vine and leaf characters considerable differences are observed among the varieties, some forming long trailing vines, while in others the trailing habit is greatly restricted or almost entirely absent. The shape and size of the leaves also differ widely, varying from the small entire heart-shaped leaves, which closely resemble those of the morning-glory, to large, shouldered, and even deeply cleft forms, which bear little resemblance to those of their close relative. Considerable variations both in size and shape often may be observed upon the same plant.

The edible portions of the plant are produced underground as modified and greatly enlarged roots. True tubers, as found in the case of the Irish potato, are never formed. Among varieties these enlarged roots vary greatly in size, shape, color of the skin and of the flesh, in sugar content, and in cooking and table qualities. In contrast to the sweet potatoes usually seen in markets and retail stores the edible roots in certain varieties may attain a length of 18 to 24 inches; in shape they vary all the way from long, cylindrical, root-like forms to spindle-shaped and more or less globoid individuals; and while in certain of the varieties the shape is more or less uniform, in others wide differences are observed in the same plant. The size is variable also, and in some instances individual roots may attain a diameter of 4 to 6 inches, weighing from 5 to 6 pounds. The surface may be smooth and regular, veined, or even deeply grooved.

The color of the skin passes through all gradations from almost white to cream, warm buff, cinnamon buff, and light Corinthian red to dark vinaceous; and the flesh among the different varieties may vary from almost white to carrot red in color.

When freshly cooked, still further differences are observed. The color of the flesh, which in the raw potato is more or less unevenly distributed, appears more uniformly dispersed in the cooked potato, which may assume cream, buff, empire yellow, orange, or other intermediate colors, depending upon the varieties concerned. In some there is a marked tendency to darken on exposure to the air, while in others this is shown to a much less extent.

The consistency, texture, flavor, and sweetness also show wide variations. These differences among the varieties, together with their difference in behavior in storage, make the selection of suitable varieties for table use, for the manufacture of numerous sweet-potato products, for commercial storage and shipment, and for the produc-

tion of attractive and desirable canned goods of very great importance.

The investigations reported upon in this paper were made possible by the presence at the Arlington Experimental Farm, where this work was done, of variety test plats, where upward of 40 varieties and strains of sweet potatoes have been under study for a number of years. J. H. Beattie and C. J. Hunn, of the Office of Horticultural and Pomological Investigations, Bureau of Plant Industry, have these varieties under observation, furnished much of the raw material, and otherwise facilitated the work. No claim is made that all varieties are embraced in this study, but all those generally considered as important are included. There has been much confusion in the variety names of sweet potatoes, and it is hoped that the studies now in progress in the Office of Horticultural and Pomological Investigations will make clear the relationship of the numerous strains.

It is possible that under different climatic and soil conditions the same varieties might have given slightly different results from those here reported. Comparative canning tests upon potatoes from other sections of the country have not been made, though these would have been of interest. The potatoes used were handled under carefully controlled conditions, and the uniform treatment which they received makes possible a direct comparison of the merits of the different varieties. This has been the object of the work, and it is believed that the information presented will be found of service not only to those interested in the canning of this product but also to those following other methods of sweet-potato utilization.

CHEMICAL COMPOSITION OF SWEET POTATOES.

In entering upon a study of this sort it is necessary to know something of the chemical composition of the material under consideration. Table 1, taken from the work of Atwater and Bryant (*1*),[1] shows the chemical composition of both the fresh sweet potato and the canned product.

TABLE 1.—*Chemical composition and calorific value of fresh and of canned sweet potatoes.*

Condition.	Constituents (per cent).						
	Water.	Protein.	Fat.	Total carbohydrate (including fiber).	Fiber.	Ash.	Fuel value per pound (calories).
Fresh, raw	69.0	1.8	0.7	27.4	1.3	1.1	570
Canned	55.2	1.9	.4	41.4	.8	1.1	820

[1] Serial numbers in parentheses (*italic*) refer to "Literature cited" at the end of this bulletin.

It will be seen from Table 1 that the sweet potato has a low moisture content; it is high in total carbohydrates and low in fat, fiber, and protein. The protein content is slightly lower than that of the Irish potato; but about half of the total nitrogen calculated as protein in the Irish potato is really in the form of amids, whereas in the sweet potato, as shown by Keitt (*11*), no amids are present. The low crude-fiber content indicates high digestibility, and the fuel value is also seen to be high.

From the standpoint of the canner the acidity of the sweet potato is of considerable importance, since it affects the transformations which take place within the can both during and after processing and likewise has an important bearing upon sterilization. Published data upon this subject, however, are meager. Bigelow and Cathcart (*2*) approached the subject from the standpoint of the hydrogen-ion concentration and give the results of six determinations upon canned sweet potatoes from different sources packed in No. 2½ and No. 3 cans and processed at different temperatures for variable lengths of time. Their determinations place the P_h value for sweet potatoes at between 5.27 and 5.56, with an average of 5.39. According to the findings of these authors the hydrogen-ion concentration of the canned sweet potatoes is a little lower than string beans and green peppers and slightly higher than spinach. Lima beans, peas, and corn show a considerably less hydrogen-ion concentration, and pumpkins and carrots somewhat more.

In the present investigations the titratable acidity was determined upon the canned material of each of the varieties and strains under study. The material examined was in the form of pie stock, which was packed dry into No. 2 tin cans and processed for 45 minutes at 116° C. Samples of 10 grams each were shaken up in 100 c. c. of distilled water, boiled one minute to expel carbon dioxid, and titrated with N/10 NaOH, using phenolphthalein as an indicator. From 3.2 to 7.3 c. c. of the standard alkali were required to neutralize the acidity of these 10-gram samples. These figures represent the extremes, the average of the 43 varieties and strains being 4.5 c. c., which shows that the sweet potato is quite low in acidity. The average titratable acidity was slightly higher in samples packed in 1920 than those packed in 1919, but this fact is not considered significant, as in some varieties the acidity was higher in 1919 than in 1920. The differences in acidity among the varieties were small, and in these tests they could not be correlated with keeping qualities, discoloration, or any other significant quality. They therefore seem to be too small to be of importance.

The most important constituents of sweet potatoes are the carbohydrates, and since the nature and relative proportions of these fundamentally affect the physical character and quality of the

canned product it is extremely desirable to know something about them. Shiver (*18*), McDonnell (*15*), and Keitt (*11*, *12*, *13*) have shown that the sweet potato has a high starch content, with somewhat variable quantities of cane sugar and dextrose. The analyses of these writers show the content of starch to vary between about 10 and 29 per cent in the freshly dug potatoes, the average being approximately 20 per cent. Considerable differences in this respect are noted in the varieties at the time of digging. Keitt (*12*, *13*) has given special attention to the moisture content and to the proportions of the various carbohydrates in sweet potatoes when dug at different stages of maturity. He notes that in the small potatoes the moisture content is comparatively low, while the starch and sugar are high; then comes a period of rapid growth, during which the water increases and the starch and sugars decrease; and as the potatoes approach maturity the tendency is for the starch to increase and the total sugars and water to decrease. The relative proportions of cane sugar and dextrose are shown to vary greatly, dependent apparently upon meteorological conditions. The total sugars during the periods of the tests varied between about 2 and 6 per cent.

During the curing process and in storage physiological changes take place which transform part of the starch to sugars and intermediate products. These transformations have been followed carefully by several investigators. Harrington (*7*) was the first investigator, apparently, to note these changes. In a study of 16 varieties, covering a period of a little more than four months, this worker found that the average water content decreased from 71.35 to 63.5 per cent, the invert sugar increased from 3.17 to 4.63 per cent, and the total sugars increased from 6.27 to 12.31 per cent. Taking as the cane-sugar content the difference between the total sugars and the invert sugar, it is found that the cane sugar increased from 3.1 to 7.68 per cent during this period. Shiver (*18*) obtained similar results, but noted a slight increase in the moisture content during storage. He showed, however, that there may be either an increase or a decrease in the moisture content, depending upon the storage conditions. Hasselbring and Hawkins (*8*, *10*) have studied the chemical changes taking place when sweet potatoes are stored at different temperatures. They find a very great decrease in the starch and dextrose and a very great increase in the cane sugar when the potatoes are stored at low temperatures. These authors (*9*) have also measured the respiration of sweet potatoes during storage and have found some loss in reducing sugars through this cause. Miyaki (*17*), in studies upon the nature of the sugars found in sweet potatoes, concluded that the reducing sugars consisted of both

dextrose and levulose and the nonreducing sugar of sucrose. The presence of pentose, galactose, mannose, and maltose was excluded by his tests.

No reference has been found in the literature relative to the nature of the coloring substances found in sweet potatoes. The possible relation of some of these to the discoloration of the canned potato makes it of interest to know something of their nature. Qualitative tests made during the course of the present studies strongly indicated that the chief coloring substances in the flesh of the deep-colored varieties belong to the carotinoid group of chemical compounds. F. M. Schertz, of the Office of Soil-Fertility Investigations, kindly made for the writers analyses of material prepared from the Gold Skin potato and reported a finding of about 0.0073 per cent of carotin and a much smaller amount of xanthophyll. In several varieties a deep-purple pigment is present in the skin and cortex. The solubility of this pigment together with its chemical characteristics strongly indicates that it is an anthocyan, but isolation of it in pure form was not attempted. It has appeared to be associated to some extent with the discoloration of the canned potato.

The gummy latex present in the sweet potato is another substance of considerable interest. There is no published work upon its chemical nature. Carver (*5*) reported the preparation of a rubber compound which was probably made from some constituent of the latex. Whether there is present a true rubber hydrocarbon is not known. The latex is of interest here because in those varieties showing an abundance of it the tendency of the canned product to discolor is more pronounced. The various strains differ considerably in the apparent quantity of latex which is present.

The sweet potato as raw material for the manufacture of numerous products has received considerable attention from several workers. Carver (*5*) has reported, in addition to the rubber compound mentioned above, the preparation from it of starch, flour, ink, and adhesive.

Gore (*6*) has announced a method of preparing a palatable sirup from the sweet potato.

Mangels and Prescott (*16*) have reported the results of investigations upon the manufacture of sweet-potato flour by the "flake" process.

In books upon canning, the sweet potato is often spoken of and directions given for handling the product, but no comprehensive study of canning problems seems to have been made.

EXPERIMENTAL CANNING TESTS.

The experimental work upon the problem of canning sweet potatoes was begun in the fall of 1918. Surplus stocks from variety and

storage tests were made available, and work was undertaken with the view to determining what varieties were best suited for canning purposes. From preliminary investigations it soon became evident that a satisfactory comparison of the different varieties could be made only after inquiry into a number of problems which presented themselves. What should be the methods used in the preliminary handling of the potatoes before placing them in the cans? What was the nature of the discoloration which occurred, and how could it be avoided? And, from the standpoint of appearance and flavor of the product, what temperatures and time periods should be adopted in the processing of the material in the cans? These were matters which received first attention. As the work progressed new facts and conditions were brought to light, so that it was found necessary to continue the studies over a period of three successive seasons. The problems involved in the canning of sweet potatoes have by no means been exhausted, but it is felt that enough has been done to warrant the presentation of the results so far obtained. These will be considered in the order of their sequence.

WORK IN 1918.

The sweet potatoes were received at the time of or shortly after digging and were not cured. On the other hand, they were held in open crates in the floor space of a large well-ventilated building, with no attempt made to control the temperature other than to prevent freezing during the latter part of the season. Experiments were begun at once and continued up to about the middle of December.

The tendency of the material to darken on exposure to the air was encountered at the outset of the work. Examination of the potatoes showed that the cortex contained the larger part of the substance causing the darkening, and it was thought that a complete removal of the cortex would greatly diminish the trouble from this cause. Since the entire cortex could not be removed satisfactorily after cooking, it was decided to peel the potatoes before cooking. Consequently, the potatoes were peeled raw and then placed immediately in water until ready for cooking. This excluded the air from them more or less and they turned brown only after long standing in the water. Brine was tried in the place of water, but it proved only slightly more effective than the water alone. Dilute citric acid was very effective, but it gave an undesirable acid taste to the product. The following procedure seemed to offer promise of avoiding most of the difficulties, and it was temporarily adopted:

(1) Peeling the potatoes raw, after washing to remove dirt, and cutting the larger potatoes into pieces to facilitate cooking.

(2) Rinsing the potatoes in cold water, placing them at once in a steam retort, and cooking for 10 minutes at a steam pressure of 10 pounds.

(3) Placing the cooked potatoes at once into No. 3 sanitary tin cans, using a wooden plunger to pack closely and firmly.

(4) Placing cans thus filled in the cooker and steaming in flowing steam for 15 minutes.

(5) Crimping on the covers, thus tightly sealing.

(6) Processing for 70 minutes at a steam pressure of 15 pounds and cooling by placing cans in tiers on the floor of the laboratory.

The varieties and strains used in these tests included the Florida, Belmont, General Grant, White "Yam," Pierson, Miles, Early Carolina, Yellow Strasburg, Early Red Carolina, Red Brazil, Yellow "Yam," Purple "Yam," Dooley, Triumph, Porto Rico, Mullihan, Norton, Haiti, Gold Skin, Japanese "Yam," Ballinger's Pride, Big-Stem Jersey, Catawba White, Catawba Yellow, Nancy Hall, Southern Queen, and a number of unnamed strains.

Upon opening the canned material for examination the product from all the varieties was found to be quite firm. The so-called moist types were somewhat softer than the dry mealy varieties, but these differences were not very marked. As will be shown later, this was in striking contrast to the findings upon potatoes canned after curing and storage. On the basis of observations made at this time the Miles appeared to be the best among the light-colored varieties, while the Dooley, Nancy Hall, and Mullihan were best among those with deep-yellow flesh. The Early Red Carolina was best among those intermediate in color.

The necessity of a full pack and a thorough exhaust was made evident by these tests. Cans which were slack filled and processed with the others showed upon opening a marked oxidation of the exposed surface and the material immediately underlying it. Those portions from which the air was excluded remained bright, as did also that in the cans properly filled and exhausted. Upon storage the contents of those cans insufficiently exhausted became in most instances entirely black, accompanied with very marked corrosion of the cans.

Close comparison of the canning quality of the varieties could not be made from this material, since the processing, which was found too severe, had caramelized some of the sugar, causing a distinct browning in the normally light-fleshed varieties and imparting to all of them a somewhat undesirable caramel flavor. Sweet potatoes packed in glass jars and processed in boiling water for one hour on each of three successive days gave a product far superior to that just described. It was apparent, therefore, that the matter of the length and temperature of processing would have to be more thoroughly investigated before much progress could be made.

In the intermittent test just mentioned it was observed that the discoloration of the cooked potatoes when exposed to the air promptly disappeared when they were packed in glass jars, partially sealed, and processed in boiling water. Exposure to air, as when an imper-

fect seal allowed the air to enter the jar during cooling, resulted in a reappearance of the discoloration; whereas in jars in which the seal was perfect the material remained bright for an indefinite period. It was therefore apparent that peeling while raw had no advantage, and in all subsequent experiments the potatoes were cooked in the skin and peeled afterwards.

In order to determine the processing temperature and time periods which would yield the desired quality from the standpoint of appearance and flavor, the following experiments were carried out.

Potatoes of the three varieties, Nancy Hall, Big-Stem Jersey, and Southern Queen, were washed, placed on trays in a steam chamber, and subjected to flowing steam for 30 minutes. At the end of this time they were removed from the chamber, rapidly peeled by hand, and then passed through a food chopper. This gave uniform material for the tests. One lot of No. 2 and No. 3 cans of each variety was sealed at temperatures ranging from 70° to 80° C., and then another lot was allowed to cool to room temperature and then processed. From each of these lots a series of cans was treated as follows:

(1) 1, 2, 3, 4, 5, and 6 hours continuously in boiling water.

(2) 1½ hours in boiling water on each of three successive days.

(3) 30, 45, 60, 75, 90, and 120 minutes in the steam retort at 109° C. (steam pressure about 5 pounds).

(4) 30, 45, 60, 75, 90, and 120 minutes at 116° C. (steam pressure about 10 pounds).

(5) 30, 45, 60, 75, 90, and 120 minutes at 121° C. (steam pressure about 15 pounds).

Examination of the contents of these cans showed that for the present needs the most satisfactory results could be obtained under the conditions described with No. 2 cans processed at 116° C. for 45 minutes and with No. 3 cans treated similarly for one hour. Satisfactory results as to quality were likewise obtained both by the intermittent processing in boiling water for 1½ hours and by continuous boiling in the water bath for three to four hours.

The supply of many of the varieties available for this work having been exhausted, it was impossible during this first season to carry out complete comparative tests based upon the data thus far obtained. Such material as did remain, however, was canned, and comparisons were made with that handled earlier in the season. The method of preparation of this material was essentially as described under the last experiment, special care being taken that the cans were properly filled with the hot material and sealed at once. No. 2 cans were employed and processing was done in the steam retort at 10 pounds' steam pressure for 45 minutes.

On opening these cans for the examination of the contents it was found that the potato was bright and attractive in color, no caramel-

ization was apparent to the taste or sight, and the results in general were satisfactory. Comparison of this material with that canned immediately after digging showed it to be far superior in quality, due to the first lot being overprocessed, and a marked difference in the consistency was noted. As before stated, those potatoes canned early in the season were firm and fairly dry, but in these the consistency was much less firm, and in such varieties as the Nancy Hall, Porto Rico, and Southern Queen the material was very soft and moist. The work of the earlier investigators upon the transformations in the starch of the sweet potato during storage suggested the possible cause of this difference in the consistency of freshly dug and of stored potatoes, but it was necessary to postpone investigations of this problem until some later date. All canned potatoes not already opened were stored for later comparisons.

WORK IN 1919.

The work of 1918 showed that sweet potatoes undergo changes in storage which greatly alter the firmness of the canned product and also that these changes differ with varieties. Since a rather complete record was secured upon the potatoes canned immediately after digging, it was thought advisable to get also a complete record of their canning qualities after the usual curing and storage.[2] For this purpose 38 varieties and strains were provided. They were dug on October 1, put into open slatted crates, and placed at once in the curing rooms. Here the temperature was maintained at about 85° F. for 10 days. At the end of this time they were transferred to the storage room, where the temperature ranged from 55° to 65° F., and were held there until used. The canning tests were made November 19 to 21.

The procedure of handling was about the same as that followed during the latter part of the preceding season. The potatoes were washed, cooked in flowing steam for 30 to 40 minutes, peeled rapidly by hand, and passed directly through a food grinder into No. 2 plain sanitary cans. Sealing was done immediately, and the temperature of the material averaged 70° to 80° C. The processing was carried out at once, one lot of each variety being given the intermittent treatment in boiling water (1½ hours on each of three successive days) and the other being processed in the steam retort at 116° C. for 45 minutes. At the end of the processing periods all cans were removed and cooled in air.

Only slight differences in quality could be noted in the material processed according to the two methods mentioned, it being judged

[2] For information upon curing and storing sweet potatoes, see Farmers' Bulletin 970, entitled "Sweet-Potato Storage."

that the potatoes processed intermittently in boiling water were perhaps slightly superior. The differences, however, were too slight to warrant the use of the more time-consuming and inconvenient intermittent treatment.

On November 26 a series of cans of these potatoes was opened before a committee of judges composed of representatives from the States Relations Service of the United States Department of Agriculture, the Research Laboratory of the National Canners' Association, and the Office of Horticultural and Pomological Investigations of the Bureau of Plant Industry, United States Department of Agriculture. In passing judgment upon these samples the committee was requested to consider the following points:

(1) Appearance, noting degree of color, brightness of material (or darkening if present), and general attractiveness of the product, having in mind the point of view of the housewife.

(2) Quality, noting the consistency, whether firm or soft, moist or dry, etc., the grain or texture of the product, presence of fiber, etc.

(3) Taste, noting the degree of sweetness, caramelization if evident, and distinctive flavors.

While individual opinions differed somewhat as to the qualities of the various samples, first place was unanimously awarded to the Gold Skin. Others that received favorable comment were Dooley, Porto Rico, Mullihan, Big-Stem Jersey, Yellow Jersey, Belmont, Yellow Strasburg, Early Red Carolina, Vineless Pumpkin "Yam," Dahomey, Pumpkin "Yam," and Southern Queen.

It should be remembered that this exhibit took into account only the quality of the canned product without regard to other important considerations. From the standpoint of the practical canner several matters in addition to the quality of the canned product must be taken into account, such as the yield per acre from any particular variety, the size and shape of the potatoes, and their ease of peeling.

As was to be expected, this test showed great differences in the firmness of the canned product. Some varieties, such as the Early Red Carolina and Big-Stem Jersey, were quite firm, while the Nancy Hall, Porto Rico, and some others were very soft. All degrees of firmness were represented among the varieties. This makes it apparent that, even with the cured and stored potatoes, by the selection of the proper varieties one may obtain a relatively dry firm pack or a moist one as desired, thus meeting all market demands.

Surplus stocks of these canned varieties were stored for comparison with later packs and to determine the keeping quality of the product.

Farther on in the text will be found a descriptive list of the varieties and strains of sweet potatoes used in these studies, and under each will be given a brief summary of the nature of the raw potatoes,

their yields, canning qualities, and other characters. These descriptions may be found of value in choosing the variety or varieties best suited for any particular purpose.

COMPARATIVE CANNING TESTS IN 1920.

There remained to be determined the comparative qualities of the different varieties when canned as whole potatoes, and certain of the problems connected with the canning of sweet potatoes required further investigation. Moreover, several additional varieties were made available for use. It was decided, therefore, to continue the studies for another season in order to make the work as complete as possible.

Forty-three varieties and strains were grown especially for this purpose. They were dug on October 14 and 15 and the main portion of each cured and stored, as in 1919. From the Porto Rico, Nancy Hall, Big-Stem Jersey, and Southern Queen varieties a sample was canned immediately; another at the end of 10 days' curing, when it was transferred to storage; a third sample after 10 days in storage; and a final sample after 20 days in storage. This was done to determine just what effect curing and storage have upon the canning qualities of different types of sweet potatoes. These results will be considered under the heading of "Consistency" (see page 16).

The main variety canning tests were made from November 26 to December 6. The handling of the potatoes differed from that of the 1919 season in that they were packed in two forms, as pie stock and as whole potatoes. For packing whole the potatoes were washed, the largest roots cut into smaller sizes to facilitate cooking, when necessary; placed on trays in a steam chamber; and cooked in steam at 100° C. for 30 to 40 minutes, or until done. They were peeled rapidly by hand while still very hot, a towel being used to protect the hands, the hot potatoes packed into No. 3 sanitary cans, and sealed immediately. The potatoes being very hot and the cans well filled, no exhaust was found necessary. The cans thus prepared were then processed at 116° C. for one hour, at the end of which time they were removed from the retort and cooled in air. The varieties canned as pie stock were handled as during the 1919 season, the material after passing through the food grinder going directly into No. 2 sanitary cans, then sealed at once, and processed immediately at 116° C. for 45 minutes.

On December 10 these samples of canned sweet potatoes, both in the form of pie stock and as whole potatoes, were submitted to a committee of judges, as in 1919. This committee was made up of representatives from the Research Laboratory of the National Canners' Association and of the States Relations Service, the Office of

Home Economics, and the Office of Horticultural and Pomological Investigations of the Department of Agriculture. The results of this exhibit were entirely similar to those of 1919. The Gold Skin was again unanimously awarded first place, and the Porto Rico, Nancy Hall, and Vineless Pumpkin "Yam" of the moist-fleshed group and the Big-Stem Jersey, Improved Big Stem, Yellow Strasburg, and Triumph of the firmer fleshed types, in about the order given, received favorable comment. It is almost certain that different conditions as regards time of digging, curing, and storage would have altered the results somewhat, but it is of interest to note that out of the first dozen selected as best varieties for canning six were selected both seasons.

Differences in the quality of the whole-potato product as compared with the pie stock were too small to be significant. This exhibit demonstrated again that a highly desirable canned product of either the dry firm type or the moist type may be secured even in the cured potatoes by the selection of the proper varieties.

DISCOLORATION.

The greatest difficulty encountered in the canning of sweet potatoes is to overcome the tendency of the product to discolor or darken when exposed to the air. When the raw potatoes are peeled by hand they turn brownish or dark-colored irregularly over the surface. This discoloration is much more pronounced in the region of the cortex, but it is apparent to a lesser extent throughout the potato. When the potatoes are cooked and then exposed to the air they oxidize somewhat and become darker. When exposed to the air for a few hours and then reheated in the absence of oxygen, this discoloration almost entirely disappears, but it promptly reappears on exposure to the air. There is an oxidase present in the sweet potato which would explain its behavior in the raw state, but this enzym does not account for the discoloration after cooking, since the darkening takes place even after the exposure of the potato to a temperature of 116° C. for one hour in the autoclave. Oxygen appears to be necessary, for this darkening does not occur in cans of sweet potatoes which have been properly exhausted.

The substance which is first formed in this discoloration seems to be very unstable. It is destroyed or changed on reheating in steam, but forms again in air.

Iron or iron salts have a very marked effect upon the discoloration, causing an intensification of it and rendering it very much more permanent. Acids tend to inhibit it and alkalis to intensify it. If sections of raw sweet potato are placed in ammonia a yellowish color at first appears, which on standing becomes green. This occurs first in the cortex and may appear throughout the entire section. Lime

water, potassium hydroxid, and sodium hydroxid all give a yellowish coloration at first, which on oxidation turns brown.

If the sweet potato is cooked in steam in such a way as to eliminate the possibility of the introduction of iron, the discoloration on exposure to air is small in extent. If to some of the material cooked in this way there is added ferric chlorid, a greenish coloration is obtained. If a quantity is mixed with iron filings and exposed to the air the whole mass soon turns black. When a quantity is treated in the same way with tin or zinc no effect is noted.

Certain substances have been extracted from the sweet potato which give reactions very similar to those above described. One of the chief substances is soluble in acetone, glacial acetic acid, 70 per cent ethyl alcohol, and in water. These substances appear to be hydroxy compounds belonging to the aromatic series.

The different varieties of sweet potatoes show considerable variation in their tendency to discolor. The Jersey group, including the Gold Skin, Big-Stem Jersey, and Early Red Carolina, show it the least of those tested, and members of the Spanish group, including the Triumph and the deeply pigmented varieties, such as the Purple "Yam," Japanese "Yam," and Dahomey, show it the most. It would seem that there might be some correlation between this pigment and the discoloration. All the varieties and strains here tested have shown these phenomena to a greater or less extent. In the light-fleshed individuals the discoloration is more apparent than in the more deeply colored varieties, though this may be due to the partial masking of it by the deep-yellow color.

If in packing sweet potatoes the cans are sealed without exhausting—that is, if air is left in the can—the product will darken. After some time in storage the metal of the container becomes badly corroded and the potato contained in it turns black. This darkening begins at the top of the can; that is, the portion exposed to the air in the can turns brown and those portions exposed to both the air and the metal of the can turn black.

However, as the oxygen and the iron become diffused into the material the whole becomes black. Those portions in actual contact with the metal of the cans, if the air is excluded, remain bright throughout. These findings are entirely contradictory to the report of Kohman (14), in which it is stated that the darkening begins at the bottom of the can where the material is in direct contact with the metal of the container. If the can is filled quite full with the potatoes at a temperature of 80° C. or above, sealed immediately, and processed, very little action upon the metal of the container is apparent and the material remains bright. The writers have kept cans of sweet potatoes handled in this way for three years under ordinary storage conditions with no discoloration taking place.

Numerous experiments were made to see whether the tendency to darken could be prevented by treatment of the potatoes with different substances. Acetic, tartaric, and sulphurous acids were found to reduce the extent of the discoloration to a minimum, but they gave an undesirable flavor to the product. Sodium chlorid in various concentrations was also tried. It was found that if whole sweet potatoes were placed in the can without packing closely and a 10 per cent salt solution was added to fill the air spaces, the discoloration was prevented. Water alone was just as effective in so far as it excluded the oxygen from the material. Some tests were made by dipping the potatoes in a 10 per cent salt solution and then filling into the can. It did not prevent discoloration in the presence of oxygen. Campbell (*4*) states that discoloration may be prevented by the use of sodium chlorid, but in these tests the salt was not effective if the exhaust was insufficient, and when the exhaust was sufficient no salt was necessary. Proper exhausting is likewise essential to prevent the loss of the bright orange or yellow color which occurs when the carotinoids that give this color are oxidized in the presence of air.

The most effective way of preventing discoloration in the can and preserving the natural bright color is to handle the potatoes so that the material after cooking is exposed to the air for the shortest possible time, filling the potatoes into the can at a temperature not below 70° C., filling the can so that there is but a very small head space, and sealing at once.

Sweet potatoes which have been properly handled during the canning operations will usually darken somewhat on exposure to the air, though ordinarily this is not sufficient to be objectionable. The amount of this discoloration depends largely upon the particular variety of potato used and especially upon the length of time the canned product has been held in storage. During these studies it was repeatedly demonstrated that whereas the canned potatoes opened and exposed to the air 10 days after packing showed discoloration on standing, the same varieties handled in the same way when opened one year after packing remained bright. This was found to hold true for all the varieties tested, but the explanation of the phenomenon can not yet be given. This fact may be of considerable practical significance.

Of particular importance is the relation of sweet-potato diseases to discoloration. Even in potatoes which are only slightly affected by fungous disease the tendency to darken is very greatly increased, and discoloration can scarcely be prevented in such material. Moreover, the discoloration arising from this cause is more permanent and can not be destroyed by any simple means. In the canned product the affected portions become brown or black in color and give a very undesirable appearance to the potatoes. In canning practice, therefore, all affected tissue must be carefully and completely removed. It has

been found necessary even to remove considerable tissue in advance of the fungous growth.

There is another type of discoloration met with in the canning of sweet potatoes which is due to the influence of heat. At very high temperatures, even in well-exhausted cans, the potatoes turn reddish brown in color; but it is more marked if oxygen is present. The condition is due to carmelization of the sugars and to changes in other constituents of the product. It is also accompanied by an alteration of flavor. Discoloration of this type is easily avoided by carefully adjusting the time and temperature of processing.

HEAT PENETRATION AND STERILIZATION.

The rate of temperature changes in sweet potatoes during canning and the influence which initial temperatures have upon it have been fully considered by the writers in United States Department of Agriculture Bulletins Nos. 956 and 1022. Extended discussion of it here, therefore, is unnecessary. Sweet potatoes have a heavy consistency, and the penetration of heat into a can of such material is very slow. If the potatoes are introduced into the can after they have cooled considerably a much longer time is required for processing and the danger of spoilage is increased. For the same reason short heating in the exhaust box is ineffective in producing a proper vacuum. No attempt was made in these studies to determine the processing temperatures and time periods necessary to effect complete sterilization. Though the statement of Weinzirl (*20*) that the sweet potato offers an unusual test of sterilization would lead one to think that it is very difficult to can successfully, three years of observation and study of sweet-potato canning lead the writers to the conclusion that this product is very easily preserved. Rigorous processing, such as is demanded by some of our standard food products, seems not to be essential to satisfactory results with sweet potatoes. Packing the potatoes into the cans at a temperature not below 70° C. and processing at 116° C. for a length of time sufficient to bring the material at the center of the can somewhat above 100° C. has given uniformly good results in the work here recorded.

Differences in the rate of heat penetration in the "dry" firm varieties and in those which are soft and "moist" have been found too slight to be of any practical significance. Modifications in the processing due to any varietal differences in potatoes, therefore, appear unnecessary.

CONSISTENCY.

The behavior of different varieties of sweet potatoes on cooking is extremely variable. Some remain quite dry and mealy and are firm

in consistency, while others become very soft and moist. Their behavior in canning is entirely similar.

The first season in which these studies were carried on the canning of the potatoes was done shortly after digging. All the varieties studied gave a product which was quite firm, though the representatives of the Jersey group were somewhat firmer than those of the other groups. The Vineless Pumpkin "Yam" and one or two others were considerably less firm. The following season the potatoes were cured after digging and then placed in storage for a time before the canning tests were made, and the results obtained were very different. All were sweeter and somewhat softer in consistency than those canned the preceding year. The Nancy Hall, Dooley, Porto Rico, and Vineless Pumpkin "Yam" yielded a very soft moist product; many others were of medium consistency, and a few, including the Big-Stem Jersey, Early Red Carolina, and Gold Skin, remained relatively firm. This matter of firmness or softness of a variety on cooking is held of much importance, because the soft moist type is in greatest favor in the South while the dry firm type has been considered most desirable for the northern market. Since the work of the two preceding years had shown that the varieties differed among themselves with respect to this property and that changes also occurred after digging, the extent of which differed with varieties, it was thought advisable to make a somewhat more detailed study, in order to determine the amount and rate of these changes and their effect upon the quality of the canned potatoes.

It was impracticable to carry on such a detailed study of all of the forty-odd varieties and strains under investigation, so the third season four representatives were chosen from the list for this work. The others were cured, stored, and canned as previously set forth. In addition to their use for comparative-quality judging and for exhibition purposes these were all submitted to consistency tests made according to the method which will be described presently in the consideration of the four selected varieties. The results of these tests will be found in a later table.

The four varieties used in the detailed studies were Big-Stem Jersey, Southern Queen, Porto Rico, and Nancy Hall. The Big-Stem Jersey was selected as the representative of the dry, firm group, the Porto Rico and Nancy Hall as representatives of the soft, moist varieties, and the Southern Queen as representative of the intermediate group. One lot from each of these varieties was canned immediately after digging; another after curing for 10 days at the average temperature of about 85° F.; a third lot after 10 days in storage at 55° to 60° F. following curing; and a fourth lot after 20 days in storage. Representative cans for each stage in the handling of the

four varieties were opened and physical tests made to determine their relative plasticity.

Not having available a suitable plastometer, the resistance of the material to pressure was measured by a simple device constructed and employed as follows: To the upper end of a plunger made from a piece of polished brass rod half a square centimeter in cross section a small weight pan of sheet tin was attached by means of a drop of solder. At just 2 centimeters from the other end of the plunger, which was carefully squared off perpendicularly to the axis, a file mark was made. This plunger, which was held in a vertical position by a glass sleeve supported in a ring stand clamp, was so arranged that the test can of material could be placed under it and the end of the plunger lowered to the surface of the material.

To carry out the test the entire end of the can was removed, the plunger lowered to the surface of the test material, and weights added to the weight pan until the plunger penetrated the material. The sum of all the weights (weight of the plunger plus the added weights), expressed in grams, required to push the plunger into the test material up to the file mark in just 1 minute was taken as the factor expressing the relative plasticity of the samples. Table 2 gives the figures thus obtained. They represent averages of many tests made upon both ends of the cans of material tested.

TABLE 2.—*Relative plasticity of sweet potatoes canned in the form of pie stock during the various stages of handling.*

Variety.	Plasticity factor (grams).			
		After curing for 10 days at 85° F.		
	Freshly dug.	No storage period.	Subsequent period of storage at 55° to 65° F.	
			10 days.	20 days.
Big-Stem Jersey	230	94	87	85
Southern Queen	92	71	34	20
Nancy Hall	104	30	22	17
Porto Rico	216	20	25	31

From the above it will be seen that at the time of digging all four varieties gave a relatively firm product. The Big-Stem Jersey and Porto Rico were especially firm. The Nancy Hall was somewhat softer, but still quite firm, while the Southern Queen ranked slightly lower. The figures obtained at the other stages of handling are very interesting. After curing, the Big-Stem Jersey lost much of its firmness but was still quite resistant to penetration. During the storage period there was a slight gradual decline, but this was not

sufficient to alter the plasticity to any marked extent. The Southern Queen changed less rapidly than any of the others during curing, but lost its firmness rapidly in storage, arriving at the end of the test period in a very soft condition. Very marked changes took place in the Nancy Hall and the Porto Rico during the curing period. At the end of this time both were very soft. A continuous loss in the case of the Nancy Hall and a slight increase in the Porto Rico are noted, but they have no practical significance probably, as both varieties had become very soft.

All the different potatoes studied have been found to vary in somewhat the same way, as is shown in the examples just given. Though, as has been pointed out, some variations have been noted in the consistency at the time of digging, all when freshly dug yield a comparatively firm product. Table 3 shows the results of consistency tests upon these varieties made after curing and storage. The tests were carried out in the same manner as in the tests just described. The varieties are arranged in the order of their firmness as found in these tests.

TABLE 3.—*Relative plasticity of different varieties of sweet potatoes canned in the form of pie stock after curing and storage.*

Variety.	Grams.	Variety.	Grams.	Variety.	Grams.
Early Red Carolina	210	No. 11284	75	No. 39833	42
No. 11286	172	Triumph	71	Key West	35
Big-Stem Jersey	158	No. 10650	68	Miles	34
Red Jersey	137	Pierson	64	Dooley	34
No. 7980	125	Florida	62	Southern Queen	30
Yellow Jersey	108	Early Carolina	60	Ballinger's Pride	30
Yellow Strasburg	105	Gros Grandia	60	Golden Beauty	29
Improved Big Stem	105	Mullihan	58	White "Yam"	29
General Grant	97	Red Brazil	52	Creola	28
No. 10412	95	Red Bermuda	50	Porto Rico	28
Dahomey	89	Catawba White	50	Vineless Pumpkin "Yam"	25
Catawba Yellow	85	Yellow Belmont	46	Nancy Hall	20
Gold Skin	82	No. 11285	45		
Haiti	81	Vineless	45		
No. 49711	78	No. 22437	45		

It will be seen that after curing and storage the plasticity varies all the way from quite firm to very soft, all degrees of plasticity being found.

These observed changes in consistency during curing and storage at once raised the question as to the cause, and the samples were submitted to chemical analysis to determine what substances were involved. The analyses were carried out in the following way: Duplicate samples of 100 grams were weighed out from the thoroughly mixed material and enough 95 per cent alcohol added to give an 80 per cent mixture. This was thoroughly stirred, and after standing for several hours the alcohol was decanted through an extraction cup into a flask and more 95 per cent alcohol added to the material. This was repeated three or four times. After decanting for the last time

the residue was transferred to the extraction cup and the extraction completed in a Soxhlet. The greater part of the extraction, therefore, was done in the cold, and the Soxhlet cup was used merely to remove the last traces of sugars. This procedure eliminated as far as possible any change during extraction.

Determination of sugars in the extract was made according to the methods of the Association of Official Agricultural Chemists, and the total polysaccharids in the residue were also determined by these methods.

It seemed desirable to know something of the nature of the polysaccharid content. In preliminary tests the residues from the firm lots gave a blue color with iodin, while the residues from the soft samples gave a red color. This seemed to indicate the presence of dextrin in the latter samples and suggested that the plasticity of the canned sweet potato might depend on whether starch or dextrin was present. The observation appeared so significant that further tests were made to determine more definitely the identity of the substance. It was found to be precipitated by alcohol; upon hydrolysis it yielded reducing sugars; it was not precipitated by basic lead acetate, gave a red coloration with iodin, and possessed adhesive properties. It was evident, therefore, that during cooking the starch had been gelatinized and that insoluble starch, soluble starch, and dextrin possibly existed in various proportions in the samples. An effort was then made to determine the amount of dextrin present.

There was no very satisfactory method for the determination of dextrin in the presence of soluble starch, but the following method was finally adopted for its estimation: 1 gram of the dried residue from the extraction was ground thoroughly with 10 to 15 c. c. of distilled water. After grinding, more water was added and the whole transferred to a 100 c. c. volumetric flask. The volume was brought to about 90 c. c. and the solution allowed to stand for 30 minutes with frequent shaking. At the end of this time 2 c. c. of a basic lead-acetate solution was added to precipitate the soluble starch and the volume then made up to 100 c. c. After shaking thoroughly it was passed through a dry filter and the rotation of the filtrate taken. The determination of dextrin from the polariscope readings was calculated by the formula given by Browne (3). It must be understood that the figures obtained are but rough approximations of the real dextrin content of the samples. For making the polariscope readings and assisting in the interpretation of the results the writers are indebted to Dr. S. F. Sherwood, of the Office of Sugar-Plant Investigations.

Table 4 shows the results of the chemical analyses of samples of four varieties of sweet potatoes canned at intervals of 10 days during curing and storage.

TABLE 4.—*Results of chemical analyses of samples of four varieties of sweet potatoes canned at intervals of 10 days during curing and storage.*

Sample.	Constitutents (per cent).						
	Moisture.	Dry weight.	Sugar content (calculated as invert).			Total polysaccharids (calculated as starch).	Dextrin.
			Reducing (before inversion).	Nonreducing.	Total.		
Big-Stem Jersey:							
Freshly dug	72.63	27.37	6.50	2.15	8.65	10.85	0
After curing 10 days	71.51	28.49	5.65	4.15	9.80	10.31	0.41
After storage—							
10 days	71.23	28.77	6.03	4.59	10.62	10.39	.....
20 days	70.40	29.60	6.11	4.51	10.62	10.36	.46
Nancy Hall:							
Freshly dug	66.80	33.20	9.17	1.89	11.06	11.02	.32
After curing 10 days	66.80	33.20	9.76	4.23	13.99	8.51	4.78
After storage—							
10 days	64.60	35.40	10.57	4.51	15.08	9.21	5.18
20 days	65.11	34.89	10.38	4.65	15.03	9.14	5.11
Southern Queen:							
Freshly dug	71.09	28.91	7.67	1.38	9.05	10.64	.17
After curing 10 days	68.62	31.38	8.18	3.74	11.92	9.53	1.33
After storage—							
10 days	68.55	31.45	9.08	3.02	12.10	10.14	4.73
20 days	68.57	31.43	8.39	3.70	12.09	9.06	3.78
Porto Rico:							
Freshly dug	70.03	29.97	6.75	1.83	8.58	11.06	0
After curing 10 days	69.15	30.85	8.90	4.88	13.78	7.65	3.92
After storage—							
10 days	68.78	31.22	8.29	5.34	13.63	8.44	3.88
20 days	68.20	31.80	8.86	4.88	13.74	9.13	3.66

From Table 4 it will be seen that the moisture content of the canned product is highest in the lots canned immediately after digging, those canned at the end of the storage period of 20 days showing a loss of from 1.6 to 2.5 per cent. The total sugar content increases in the succeeding tests and the total polysaccharids, calculated as starch, decrease, but these changes seem insufficient to account for the enormous change in plasticity.

The dextrin content of the samples is of interest. In the Big-Stem Jersey none was found in the material canned from freshly dug potatoes, and only a relatively small amount in any of the lots canned subsequently. In the Nancy Hall there was a small amount of dextrin in the material from the freshly dug potatoes and this quantity greatly increased in the material from the cured and from the stored potatoes. The Southern Queen showed a small dextrin content in the lot from the freshly dug roots, a larger amount in material cured for 10 days, though less than is formed in the corresponding lots of Nancy Hall and Porto Rico, and a considerable amount in the lots from stored potatoes. The figures for the Porto Rico are similar to those for the Nancy Hall except that no dextrin is found in material from the freshly dug potatoes and the figures in the succeeding lots are somewhat lower. From qualitative tests made in connection with these studies but not recorded here it seems almost certain that

the percentage of dextrin is considerably higher than the figures indicate.

These figures are of especial significance when they are correlated with those for the plasticity of samples given in Table 2. The marked increase in dextrin content corresponds exactly in point of its appearance with the softening of the potato. In the Nancy Hall and Porto Rico this occurs after 10 days' curing of the potatoes, while in the Southern Queen the marked increase is found in the lot canned after 10 days' storage following curing. The marked firmness of the Big-Stem Jersey canned at the end of 20 days of storage likewise coincides with the low dextrin content found. Considering the fact that both in the determination of the plasticity and in the determination of the dextrin the methods used were crude, the relatively close correlation of the two sets of figures appears significant.

Samples of the Porto Rico variety canned immediately after digging gave a blue coloration with iodin, characteristic of starch, but the same variety after 10 days of curing gave a reddish color with iodin. The Big-Stem Jersey, on the other hand, gave a blue coloration with iodin at each of the stages of curing and storage. It seems, therefore, that after cooking the soft potatoes contain dextrin instead of starch as the chief polysaccharid, while the firmer ones contain starch largely. It appears, therefore, that the plasticity of the sweet potato after cooking is dependent upon the ratio of starch to water present. During curing and storage, transformations take place which on cooking result in the change of starch to variable proportions of sugar, dextrin, and probably all the intermediate products, depending upon the particular variety of sweet potato used.

This work suggests that the differences in the cooking quality of varieties of the Irish potato may be due to causes of a similar nature.

In making sweet-potato flour by the flake process Mangels and Prescott (*16*) state that there developed hygroscopic and gummy substances which interfered with the success of the process. These workers used the Porto Rico, Nancy Hall, and Southern Queen varieties, and the experiments were made in the late winter. Their results are not surprising, therefore, for their material must certainly have contained a large percentage of dextrin. The chances of success would have been much better if the firm-fleshed varieties or freshly dug potatoes had been used.

It is shown by these tests that in some varieties the changes that cause the loss of firmness occur rather quickly after digging. At this point attention should be drawn perhaps to the fact brought out in the work of some of the earlier investigators (*12*) that changes occurring in sweet potatoes begin to some extent even before digging. It is probable, therefore, that the firmness varies somewhat with

the time of digging. It has not been possible for the writers as yet to test the different varieties in this respect.

In considering the table qualities of the sweet potatoes canned immediately after digging and of those canned after the usual curing and storage, preferences, so far as it has been possible to obtain them, seem to favor the latter, since in the curing and subsequent storage the sweetness increases and the distinctive flavors become more fully developed. For certain culinary uses, however, the firmer product from the freshly dug potatoes would be more adaptable; and those persons favoring a dry potato would doubtless find that the physical qualities obtained would more than offset the added sweetness and flavor.

When canned after curing and storage, the soft-fleshed varieties, like the Nancy Hall, Porto Rico, etc., yield during the canning process a liquid which is quite sweet. This is what gives to these varieties their moist appearance. The presence of this liquid does not signify a high moisture content, however, for in these varieties the moisture may be actually lower than in that of the Big-Stem Jersey and others of the firm types. The proportion of starch present seems to account largely for this condition.

VARIETIES AND STRAINS OF SWEET POTATOES USED IN THESE TESTS.

The following brief descriptive list of the varieties and strains of sweet potatoes used in these studies is given not for its taxonomic value but to assist the practical worker in the selection of suitable varieties to meet particular needs. Those interested in the classification of the sweet-potato varieties should consult the work of Thompson and Beattie (*19*).

The statements regarding vine and root characters are based upon the work of the above authors, confirmed by field observations. The productiveness of varieties and strains is indicated by terms descriptive of results obtained at the Arlington Experimental Farm, it being recognized that yields vary considerably under different climatic and soil conditions.

The terms defining the color of the skin, flesh, and cooked potato are taken from the work of Ridgway,[3] with the colored plates of which the writers have made direct comparisons. Skin colors may vary with different soils. The colored plates found at the end of this bulletin (Pls. I to III) show the shades of color of the canned product of the different varieties here listed.

Firmness and softness of the canned product have been graded under the heads "very firm," "firm," "medium firm," "medium

[3] Ridgway, Robert. Color Standards and Color Nomenclature. 43 p., 53 pl. (col.). Washington, D. C. 1912.

soft," "soft," and "very soft." An idea of the values attached to these grades may be gained by taking the product of the freshly dug Big-Stem Jersey as "very firm" and that of the cured and stored Nancy Hall as "very soft."

The "peeling quality" indicates the relative ease with which the cooked potatoes are peeled by hand.

The quality of the canned product is graded as "very good," "good," "fair," "poor," and "very poor," which terms are self-explanatory. The canning quality ascribed to the varieties and strains is based upon the results of comparative canning tests and quality judging for three seasons.

Certain potatoes in the list bear numbers only. These are unnamed strains under study at the Arlington Experimental Farm which were canned along with the named varieties.

DESCRIPTIVE LIST.

Ballinger's Pride (a strain of Southern Queen). Vines large and vigorous, long, 6 to 12 feet. Roots medium to large in size, fusiform, smooth, and regular. Yields, medium heavy. Color of skin, cream color. Color of flesh, massicot yellow to ivory yellow. Peeling quality, poor. Color of cooked potato, empire yellow to apricot yellow (Pl. I, fig. 1). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, very soft. Tendency to darken, pronounced. Canning quality, fair.

Belmont. Vines low, long trailing. Roots medium in size, fusiform in shape, smooth. Color of skin, cream buff, frequently mottled with pinkish buff. Color of flesh, uniform ivory yellow. Cortex splashed with flesh color. Peeling quality, fair to good. Color of cooked potato, apricot yellow (Pl. I, fig. 2). Consistency of freshly dug potato, firm. Consistency after curing and storage, medium soft. Tendency to darken, rather pronounced. Canning quality, poor to fair.

Big-Stem Jersey. Vines moderately large growing, long, 6 to 12 feet. Roots small to large in size, long fusiform in shape, smooth or veined, regular. Yields, medium heavy. Color of skin, cinnamon buff. Color of flesh, amber yellow to straw yellow, mottled with flesh color. Peeling quality, fair to poor. Color of cooked potato, deep chrome to apricot yellow (Pl. I, fig. 3). Consistency of freshly dug potato, very firm. Consistency after curing and storage, firm. Tendency to darken, little. Canning quality, good.

Catawba White (a strain of Southern Queen). Vines large and vigorous, long, 6 to 12 feet. Roots medium to large in size, fusiform, globoid or ovoid in shape, smooth and regular. Yields, light to medium. Color of skin, cream buff. Color of flesh, ivory yellow. Peeling quality, fair. Color of cooked potato, apricot yellow to light orange yellow (Pl. I, fig. 4). Consistency of freshly dug potato, firm. Consistency after curing and storage, medium soft. Tendency to darken, pronounced. Canning quality, fair.

Catawba Yellow (a strain of Southern Queen). Vines large and vigorous, long, 6 to 12 feet. Roots medium to large in size, fusiform, globular or ovoid in shape, smooth and regular. Yields, light. Color of skin, cream buff. Color of flesh, fairly uniform ivory yellow. Peeling quality, fair. Color of cooked potato, empire yellow (Pl. I, fig. 5). Consistency of freshly dug potato, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, fair.

Creola. Vines vigorous, long to very long, 8 to 20 feet. Roots medium to large in size, oblong to fusiform in shape, regular and smooth. Yields, medium heavy. Color of skin, flesh color to salmon color. Color of flesh, uniformly straw yellow. Peeling quality, good. Color of cooked potato, apricot yellow to empire yellow (Pl. I, fig. 6). Consistency of freshly dug potatoes, medium firm. Consistency after curing and storage, very soft. Tendency to darken, little. Canning quality, fair.

Dahomey. Vines medium to long, 6 to 10 feet. Roots long cylindrical in shape. Yields, medium heavy. Color of skin, neutral red. Color of flesh, marguerite yellow. Peeling quality, poor. Color of cooked potato, straw yellow (Pl. I, fig. 7). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, fair.

Dooley. Vines long to very long, 10 to 15 feet. Roots large in circumference, short fusiform in shape. Yields, heavy. Color of skin, light ochraceous buff with cream-buff veins. Color of flesh, flesh color interspersed with straw yellow. Cortex, ochraceous salmon. Peeling quality, good. Color of cooked potato, orange (Pl. I, fig. 8). Consistency of freshly dug potato, firm to medium firm. Consistency after curing and storage, soft to very soft. Tendency to darken, little. Canning quality, good.

Early Carolina (a strain of Yellow Jersey). Vines medium long trailing. Roots medium in size, fusiform in shape, regular. Yields, medium heavy. Color of skin, cinnamon buff. Color of flesh, colonial buff with considerable salmon color especially prominent near the cortex. Peeling quality, good. Color of cooked potato, empire yellow to apricot yellow (Pl. I, fig. 9). Consistency of freshly dug potato, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, fair.

Early Red Carolina (probably same as Red Jersey). Vines medium long, low trailing. Roots medium to small, fusiform to globoid in shape, smooth and regular. Yields, medium heavy. Color of skin, deep Corinthian red. Color of flesh, massicot yellow, with small areas of flesh color. Somewhat variable. Peeling quality, rather poor. Color of cooked potato, apricot yellow to empire yellow (Pl. I, fig. 10). Consistency of freshly dug potato, very firm. Consistency after curing and storage, firm. Tendency to darken, little. Canning quality, good.

Florida. Vines large, vigorous, medium in length, 4 to 9 feet. Roots medium in size, long fusiform in shape, fairly smooth and regular. Yields, medium heavy. Peeling quality, poor. Color of cooked potato, buff yellow (Pl. I, fig. 11). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, poor.

General Grant. Vines medium to large, vigorous, medium in length, 4 to 10 feet. Roots medium in size, short fusiform to long fusiform in shape, smooth and regular. Yields, light to medium. Color of skin, cream buff frequently mottled with pale cinnamon pink. Color of flesh, flesh to straw yellow grading to almost white, mottled with pale cinnamon pink. Peeling quality, poor. Color of cooked potato, buff yellow (Pl. I, fig. 12). Consistency of freshly dug potato, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, poor.

Golden Beauty (same as Porto Rico). Vines vigorous, medium long, spreading. Roots medium to large in size, fusiform to globular and irregular in shape, smooth. Yields, heavy. Color of skin, flesh color to Japan rose. Color

of flesh, carrot red to flesh color, irregularly mixed with buff yellow. Peeling quality, good. Color of cooked potato, orange (Pl. I, fig. 13). Consistency of freshly dug potato, very firm. Consistency after curing and storage, very soft. Tendency to darken, little. Canning quality, very good.

Gold Skin. Vines medium to long, slender, 6 to 10 feet. Roots, small to medium, fusiform in shape, smooth and regular. Yields, medium to heavy. Color of skin, ochraceous buff. Color of flesh, salmon buff with streaks of straw yellow. Cortex, maize yellow. Peeling quality, good. Color of cooked potato, deep chrome (Pl. I, fig. 14). Consistency of freshly dug potatoes, very firm. Consistency after curing and storage, medium firm. Tendency to darken, little or none. Canning quality, very good.

Gros Grandia. Vines short to vineless, 1½ to 3 feet, stems very coarse. Roots cylindrical, veins slightly raised. Yields, light to medium. Color of skin, light Corinthian red to dark vinaceous. Color of flesh, almost white. Peeling quality, good. Color of cooked potato, cream (Pl. I, fig. 15). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, poor.

Haiti. Vines quite vigorous, spreading. Roots medium to very large in size, irregular, grooved. Yields, medium to heavy. Color of skin, deep hellebore red. Color of flesh, ivory yellow with traces of flesh color. Peeling quality, good. Color of cooked potato, empire yellow to apricot yellow (Pl. II, fig. 1). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, little. Canning quality, fair.

Improved Big Stem (same as Big-Stem Jersey). Vines medium vigorous, long, low trailing. Roots medium in size, fusiform in shape. Yields, medium heavy. Color of skin, cinnamon buff. Color of flesh, amber yellow to straw yellow, mottled with flesh color. Somewhat variable. Peeling quality, poor. Color of cooked potato, empire yellow to apricot yellow (Pl. II, fig. 2). Consistency of freshly dug potatoes, very firm. Consistency after curing and storage, firm. Tendency to darken, pronounced. Canning quality, fair to good.

Japanese "Yam." Vines vigorous, medium long. Roots elongated, cylindrical, irregular. Yields, medium heavy. Color of skin, deep hellebore red to neutral red. Color of flesh, fairly uniform ivory yellow. Peeling quality, good. Color of cooked potato, amber yellow (Pl. II, fig. 3). Consistency of freshly dug potato, firm to medium firm. Consistency after curing and storage, soft. Tendency to darken, pronounced. Canning quality, poor to fair.

Key West. Vines medium to long, 4 to 10 feet, stems coarse. Roots medium to large, medium to long, cylindrical in shape. Yields, medium to heavy. Color of skin, buff pink, slightly deeper around the eyes. Color of flesh, straw yellow. Peeling quality, fair. Color of cooked potato, apricot yellow to empire yellow (Pl. II, fig. 4). Consistency of freshly dug potatoes, medium firm. Consistency after curing and storage, soft. Tendency to darken, pronounced. Canning quality, fair.

Miles (a strain of Southern Queen). Vines vigorous, rather coarse. Roots medium sized, fusiform in shape, smooth and regular. Yields heavy. Color of skin, massicot yellow. Color of flesh, massicot yellow grading to nearly white. Peeling quality, poor. Color of cooked potato, empire yellow to apricot yellow (Pl. II, fig. 5). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, soft. Tendency to darken, pronounced. Canning quality, fair.

Mullihan (a strain of Nancy Hall). Vines vigorous, stems rather coarse. Roots medium sized, fusiform in shape, smooth, regular. Color of skin, warm buff more or less suffused with light ochraceous salmon. Color of flesh, straw color intermixed with flesh color. Peeling quality, good. Color of cooked potato, cadmium yellow to capucine yellow (Pl. II, fig. 6). Consistency of freshly dug potato, firm. Consistency after curing and storage, soft. Tendency to darken, little. Canning quality, good.

Nancy Hall. Vines medium in length, vigorous, 4 to 8 feet. Roots medium to large in size, fusiform in shape, veined or smooth and regular. Yields heavy. Color of skin, warm buff, more or less suffused with light ochraceous salmon. Color of flesh, straw color intermixed with flesh color. Peeling quality, good. Color of cooked potato, cadmium yellow to capucine yellow (Pl. II, fig. 7). Consistency of freshly dug potato, firm. Consistency after curing and storage, very soft. Tendency to darken, little. Canning quality, good.

Pierson. Vines large, vigorous, long creeping, 6 to 15 feet. Roots medium to very large in size, fusiform and ovoid in shape, strongly ribbed and veined, very rough. Yields heavy. Color of skin, cream buff. Color of flesh, colonial buff to massicot yellow. Peeling quality, poor. Color of cooked potato, apricot yellow to empire yellow (Pl. II, fig. 8). Consistency of freshly dug potatoes, medium firm to firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, poor.

Porto Rico. Vines medium to long, 5 to 10 feet, stems coarse. Roots medium to large in size, fusiform to globular and irregular in shape, smooth. Yields heavy. Color of skin, flesh color to Japan rose. Color of flesh, carrot red to flesh color, irregularly mixed with buff yellow. Peeling quality, good. Color of cooked potato, orange (Pl. II, fig. 9). Consistency of freshly dug potatoes, firm to very firm. Consistency after curing and storage, very soft. Tendency to darken, little. Canning quality, very good.

Pumpkin "Yam." Vines moderately large growing, long, 6 to 12 feet. Roots medium in size, fusiform in shape, mostly regular with few veins. Yields, medium to heavy. Color of skin, pinkish cinnamon. Color of flesh, carrot red to salmon color with irregular areas of ivory yellow. Peeling quality, good. Color of cooked potato, orange (Pl. II, fig. 10). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, very soft. Tendency to darken, little. Canning quality, good.

Purple "Yam" ("Nigger Choker"). Vines long and vigorous, 5 to 16 feet. Roots long cylindrical, regular or irregular in shape, medium to large in size, smooth. Yields, medium heavy. Color of skin, neutral red. Color of flesh, almost white with occasional magenta purple stains. Cortex, dull magenta purple. Peeling quality, poor. Color of cooked potato, cream buff. (Pl. II, fig. 11). Consistency of freshly dug potatoes, very firm. Consistency after curing and storage, firm. Tendency to darken, very pronounced. Canning quality, poor.

Red Bermuda. Vines large and vigorous, long creeping, 6 to 12 feet. Roots medium to large, short fusiform, globular, or ovoid in shape, irregular, and strongly ribbed and veined. Yields heavy. Color of skin, irregular, principally Indian lake with warm buff interspersed. Color of flesh, cream. Peeling quality, fair. Color of cooked potato, empire yellow to apricot yellow (Pl. II, fig. 12). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, fair to good.

Red Brazil. Vines long to very long, 6 to 20 feet, vigorous, stems medium coarse. Roots large, globular, ribbed and irregular, surface smooth. Color of skin, light Corinthian red. Color of flesh, massicot yellow. Cortex, colonial buff. Peeling quality, good. Color of cooked potato, empire yellow to apricot yellow (Pl. II, fig. 13). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, fair to good.

Red Jersey. Vines long, medium vigorous, low trailing. Roots medium to small, fusiform in shape, regular and smooth. Yields, medium heavy. Color of skin, Indian lake. Color of flesh, cream with areas of mustard yellow, especially below cortex, and small stains of carrot red. Somewhat variable. Peeling quality, fair. Color of cooked potato, apricot yellow to empire yellow (Pl. II, fig. 14). Consistency of freshly dug potatoes, very firm. Consistency after curing and storage, firm. Tendency to darken, little. Canning quality, good.

Southern Queen. Vines large and vigorous, 6 to 12 feet. Roots medium to large, fusiform globular, or ovoid in shape, somewhat veined or smooth, regular. Yields heavy. Color of skin, cream buff, frequently mottled with pale cinnamon pink. Color of flesh, massicot yellow. Peeling quality, fair. Color of cooked potato, apricot yellow to empire yellow (Pl. II, fig. 15). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, soft. Tendency to darken, pronounced. Canning quality, fair.

Triumph. Vines coarse and vigorous, short, 2 to 4 feet, bushy. Roots medium to large in size, medium to long cylindrical in shape. Yields heavy. Color of skin, chamois. Color of flesh, uniform ivory yellow. Peeling quality, good. Color of cooked potato, pinard yellow to buff yellow (Pl. III, fig. 1). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, little. Canning quality, fair to good.

Vineless Pumpkin "Yam." Vines medium in length, 4 to 8 feet. Roots medium in size, fusiform to ovoid or cylindrical in shape with few low veins. Yields, medium heavy. Color of skin, light ochraceous buff. Also has fine netted appearance. Color of flesh, flesh ocher, intermixed with straw yellow. Somewhat variable. Peeling quality, good. Color of cooked potato, orange to cadmium (Pl. III, fig. 2). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, very soft. Tendency to darken, little. Canning quality, good.

Vineless "Yam." Vines fairly vigorous, compact, dense, bushy. Roots medium in size, fusiform in shape, smooth. Yields light. Color of skin, cinnamon buff. Color of flesh, ivory yellow suffused with pale pinkish cinnamon. Peeling quality, poor. Color of cooked potato, apricot yellow to empire yellow (Pl. III, fig. 3). Consistency of freshly dug potatoes, medium firm. Consistency after curing and storage, soft. Tendency to darken, pronounced. Canning quality, fair.

White "Yam." Vines medium in length and vigor. Roots medium in size, fusiform, regular. Yields, medium heavy. Color of skin, cream buff. Color of flesh, massicot yellow. Peeling quality, very poor. Color of cooked potato, empire yellow to apricot yellow (Pl. III, fig. 4). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, very soft. Tendency to darken, pronounced. Canning quality, fair.

Yellow Jersey. Vines small, slender, long, 6 to 12 feet. Roots small to medium in size, long or short fusiform to globular or ovoid in shape, smooth or veined. Yields, medium to heavy. Color of skin, cinnamon buff. Color of flesh, colonial buff interspersed with salmon color. Peeling quality, fair. Color of cooked potato, empire yellow to apricot yellow (Pl. III, fig. 5). Consistency after curing and storage, firm. Tendency to darken, little or none. Canning quality, good.

Yellow Strasburg. Vines large and vigorous, long, creeping, 6 to 15 feet. Roots medium to large in size, ovoid or globular in shape, fairly smooth and regular or quite irregular. Yields, very heavy, heaviest of varieties under study. Color of skin, cream buff. Color of flesh, uniformly massicot yellow, Cortex, straw yellow. Peeling quality, fair. Color of cooked potato, empire yellow to apricot yellow (Pl. III, fig. 6). Consistency of freshly dug potatoes, very firm. Consistency after curing and storage, firm. Tendency to darken, little. Canning quality, good.

Yellow "Yam." Vines low and slender, long creeping, 6 to 12 feet. Roots medium in size, fusiform in shape, low veins, regular. Yields, medium to heavy. Color of skin, cream buff. Color of flesh, nearly uniform ivory yellow with occasional flecks of flesh color in the cortex. Peeling quality, good. Color of cooked potato, apricot yellow to light orange yellow (Pl. III, fig. 7). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium soft. Tendency to darken, little. Canning quality, fair.

No. 10412. Vines vigorous, long, spreading. Roots medium to very large, somewhat ribbed, fairly smooth. Yields, medium to heavy. Color of skin, dark vinaceous. Color of flesh, uniform straw yellow. Peeling quality, fair. Color of cooked potato, empire yellow to apricot yellow (Pl. III, fig. 8). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, very pronounced. Canning quality, fair.

No. 10650. Vines vigorous, long, spreading. Roots medium to very large, fusiform to globular in shape, ribbed, and irregular. Yields, medium heavy. Color of skin, dark vinaceous to slightly lighter shade, irregular. Color of flesh, uniform straw yellow. Peeling quality, good. Color of cooked potato, empire yellow to apricot yellow (Pl. III, fig. 9). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, fair.

No. 11284. Vines vigorous, long, spreading. Roots medium to large in size, irregular, ribbed. Yields light. Color of skin, dark vinaceous. Color of flesh, fairly uniform straw yellow. Peeling quality, fair. Color of cooked potato, empire yellow (Pl. III, fig. 10). Consistency of freshly dug potatoes, firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, fair.

No. 11285. Vines vigorous, spreading. Roots medium to very large, irregular, ribbed. Yields, medium heavy. Color of skin, cream color. Color of flesh, straw yellow. Peeling quality, fair. Color of cooked potato, empire yellow to apricot yellow (Pl. III, fig. 11). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, medium soft. Tendency to darken, pronounced. Canning quality, poor.

No. 12686. Vines medium vigorous, long, low, spreading. Roots medium to large, irregular, ribbed. Yields, medium heavy. Color of skin, dark vinaceous to slightly lighter shade, irregular. Color of flesh, uniform straw yellow. Peeling quality, fair. Color of cooked potato, empire yellow to

apricot yellow (Pl. III, fig. 12). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, soft. Tendency to darken, pronounced. Canning quality, fair.

No. 39833. Vines vigorous, stalky, somewhat bunchy. Roots medium to very large in size, elongated, irregular. Yields, medium heavy. Color of skin, light buff. Color of flesh, baryta yellow. Peeling quality, good. Color of cooked potato, empire yellow (Pl. III, fig. 13). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, soft. Tendency to darken, very pronounced. Canning quality, fair.

No. 49711. Vines vigorous, spreading. Roots medium to large, fusiform in shape, smooth. Yields, medium heavy. Peeling quality, fair. Color of skin, light buff. Color of flesh, baryta yellow. Color of cooked potato, empire yellow to apricot yellow (Pl. III, fig. 14). Consistency of freshly dug potatoes, firm to medium firm. Consistency after curing and storage, medium firm. Tendency to darken, pronounced. Canning quality, fair.

SUMMARY.

(1) In the comparative tests of the canning qualities of sweet-potato varieties and strains grown at the Arlington Experimental Farm the Gold Skin was awarded first place for two consecutive seasons by the committee judging the quality of the product. Of the other varieties the Yellow Jersey, Early Red Carolina, and Big-Stem Jersey represent the best of the dry firm types; the Dooley, Porto Rico, Nancy Hall, Mullihan, and Vineless Pumpkin "yam" the deep-colored moist group; and the Belmont, Miles, and Yellow Strasburg the lighter fleshed medium moist type.

(2) In determining the value of any variety for canning purposes there are many things to be considered, such as size, shape, ease of peeling, and yield per acre. Several varieties that are satisfactory on these points vary greatly in firmness, color, sweetness, and flavor. The final choice depends upon what is desired in the finished product. The Porto Rico, Dooley, and Vineless Pumpkin "Yam" are deep-colored sweet varieties, but they have a tendency to become very soft in storage. The Triumph, Miles, and Southern Queen are light colored, but become soft to medium soft in storage. The Big-Stem Jersey, Early Red Carolina, and Yellow Jersey are intermediate in color and yield the firmest product of any of the varieties. Almost every combination of qualities is found in some variety.

Certain changes take place after digging which alter greatly the firmness, flavor, and sweetness of the canned product. The varieties differ in the degree of change in each of these characters. This behavior greatly aids in choosing the type of product that the market demands. The home canner will find something desirable whatever may be his particular preference.

(3) In these tests material from each of the varieties has been canned as nearly whole as possible and also after passing through a food grinder in order to obtain a uniform product. The ground ma-

terial, commonly known as "pie stock," is more uniform in color and texture and is equally as attractive. It is suitable for making pies, puddings, etc., and the firmer varieties may even be sliced and used in other ways. The material canned as whole potatoes retains to a greater degree the original form and shape of the potatoes, which seems to be the only possible advantage to the housewife. For the canner, packing whole may have a slight advantage in that the method is simpler, but canning as pie stock utilizes the entire crop, large potatoes as well as small.

(4) The principal difficulty in canning sweet potatoes is due to the tendency of the cooked potato to darken on exposure to the air. When it is cooked in steam so as to exclude the air it assumes a clear bright color. On cooling in the air a darkening occurs, which is more marked in some varieties than in others. This discoloration disappears on reheating in steam but reappears on exposure to air. Metallic iron and iron salts accelerate and intensify this discoloration, and when large quantities are present and the material is exposed to the air for a considerable time it becomes black and the original brightness is not regained by reheating.

In canning sweet potatoes if the air or oxygen is not excluded the mass darkens, the metal of the container is acted upon, and the material in time becomes black. If the air or oxygen is excluded the material remains bright. Filling the can at a temperature of 80° C. or above and sealing at once effect this more easily and completely than filling the can cold and then exhausting in the usual way. If the can is opened immediately after processing there is a slight tendency to darken on exposure to the air, but this tendency slowly disappears in storage. In these tests material kept in cans for one year showed no tendency to darken on exposure to the air.

(5) The physical character of sweet potatoes is such that the penetration of heat into the mass is very slow. This so affects the length of the processing necessary to sterilize the product that the material should be filled into the can hot, sealed at a temperature not below 70° C., and processed immediately. If it becomes necessary to delay the work, the cans should be kept at the sealing temperature until they can be processed. The rate at which heat penetrates the can varies but little among the different varieties, and for practical purposes the variation is negligible.

(6) The sweet potato has a high sugar content; hence, its flavor and quality are easily injured by long cooking at high temperatures. The time and temperature of processing, therefore, must be carefully adjusted.

(7) The plasticity of the sweet potato after cooking is due to the nature of its carbohydrate content. The potatoes which remain firm after cooking contain a high percentage of starch, while those which

become soft have a low percentage of starch but a comparatively high percentage of dextrin. During canning, storage, and cooking the starch is transformed into sugar, dextrin, and probably all the intermediate products, the proportions in which they are formed varying with the method of handling and with different varieties. Changes in plasticity are due to these transformations, which affect the ratio of starch to moisture.

(8) The essential points in the canning of sweet potatoes are:

(*a*) Steaming for a sufficient length of time to make peeling rapid and easy and to cook the potato.

(*b*) Handling so as to expose the cooked material to the air for the minimum time possible.

(*c*) Packing the cans as full as convenient in order to eliminate oxygen and prevent darkening.

(*d*) Filling the can with material as hot as possible, not below 70° C., in order to exclude oxygen and shorten the processing period required.

(*e*) Avoiding bringing the material into contact with iron or iron compounds.

(*f*) Processing the material the minimum length of time necessary to insure its safe preservation.

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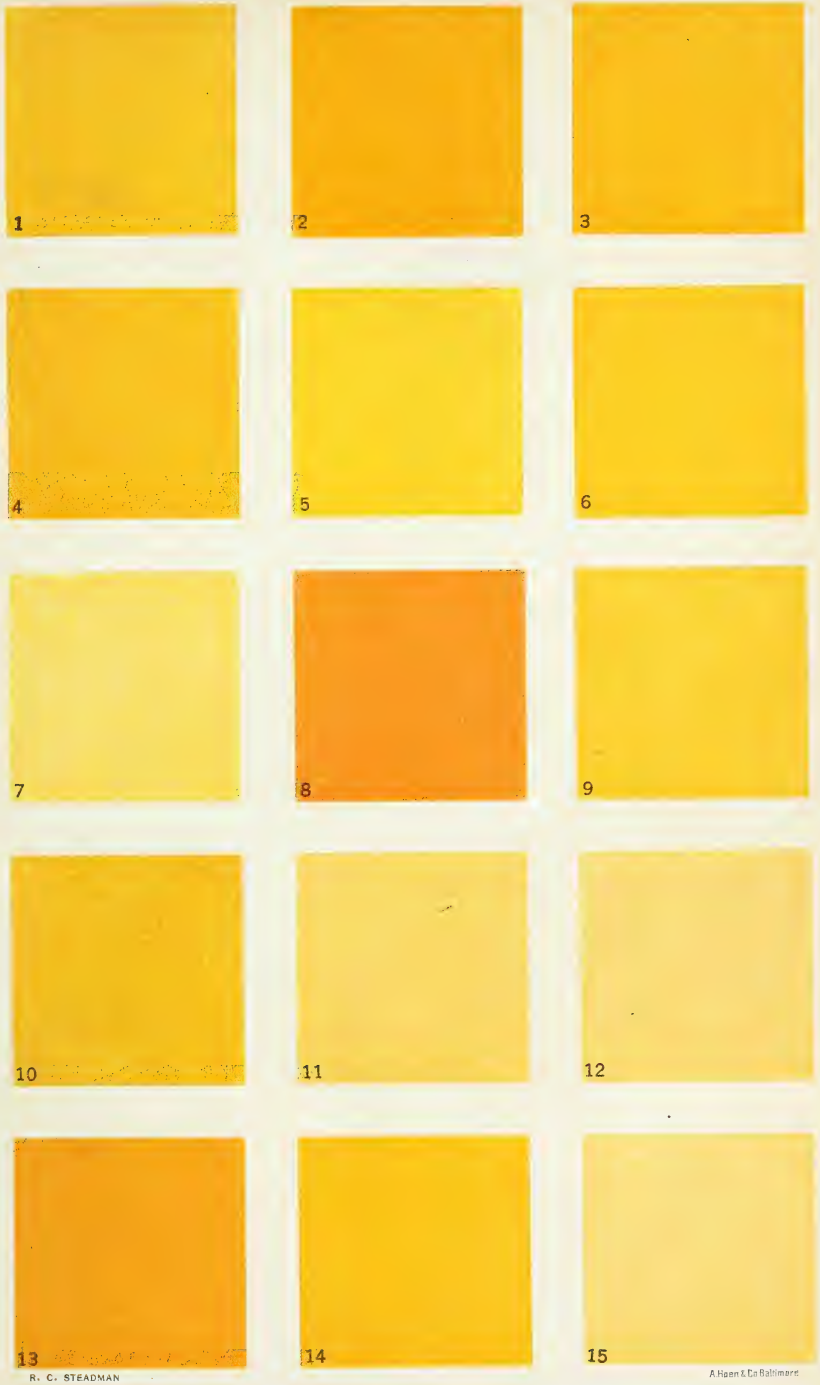

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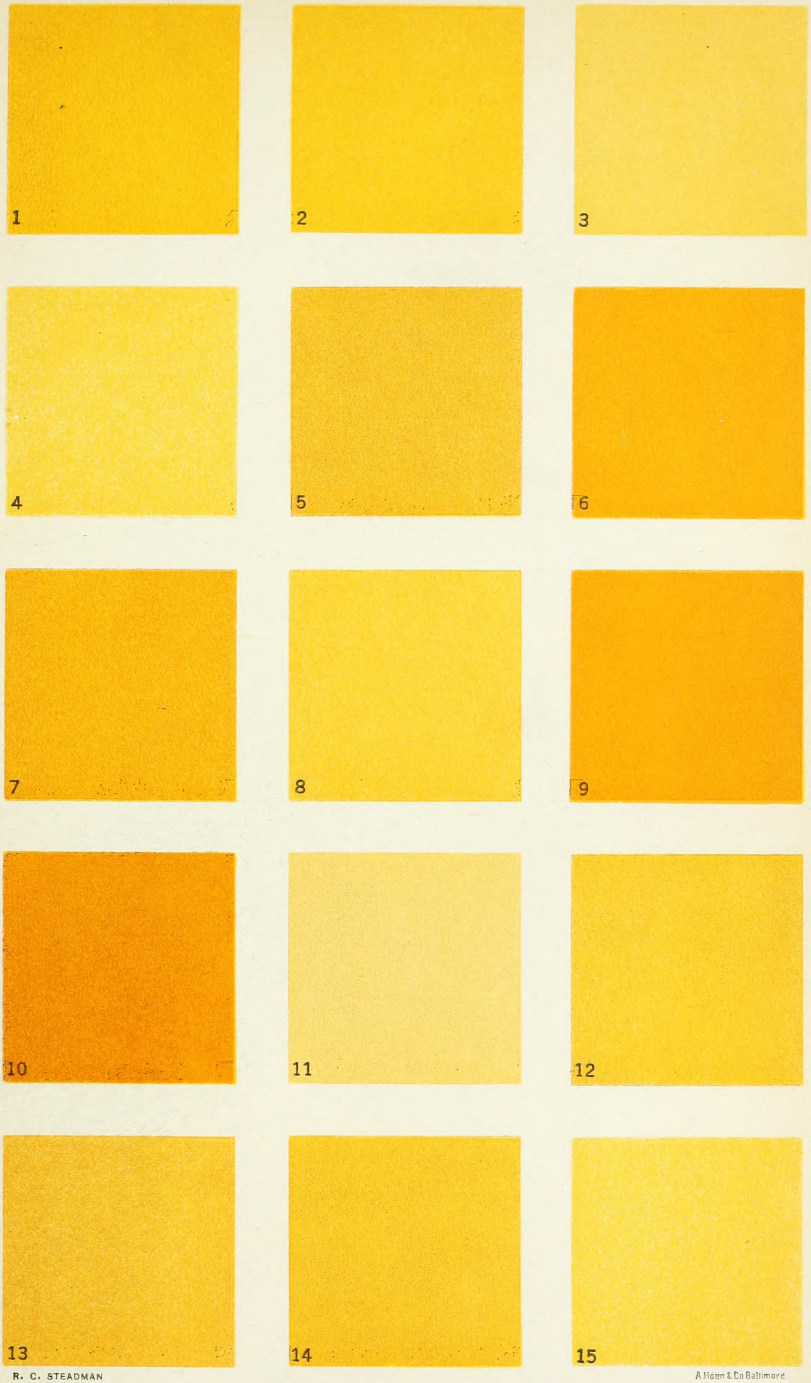
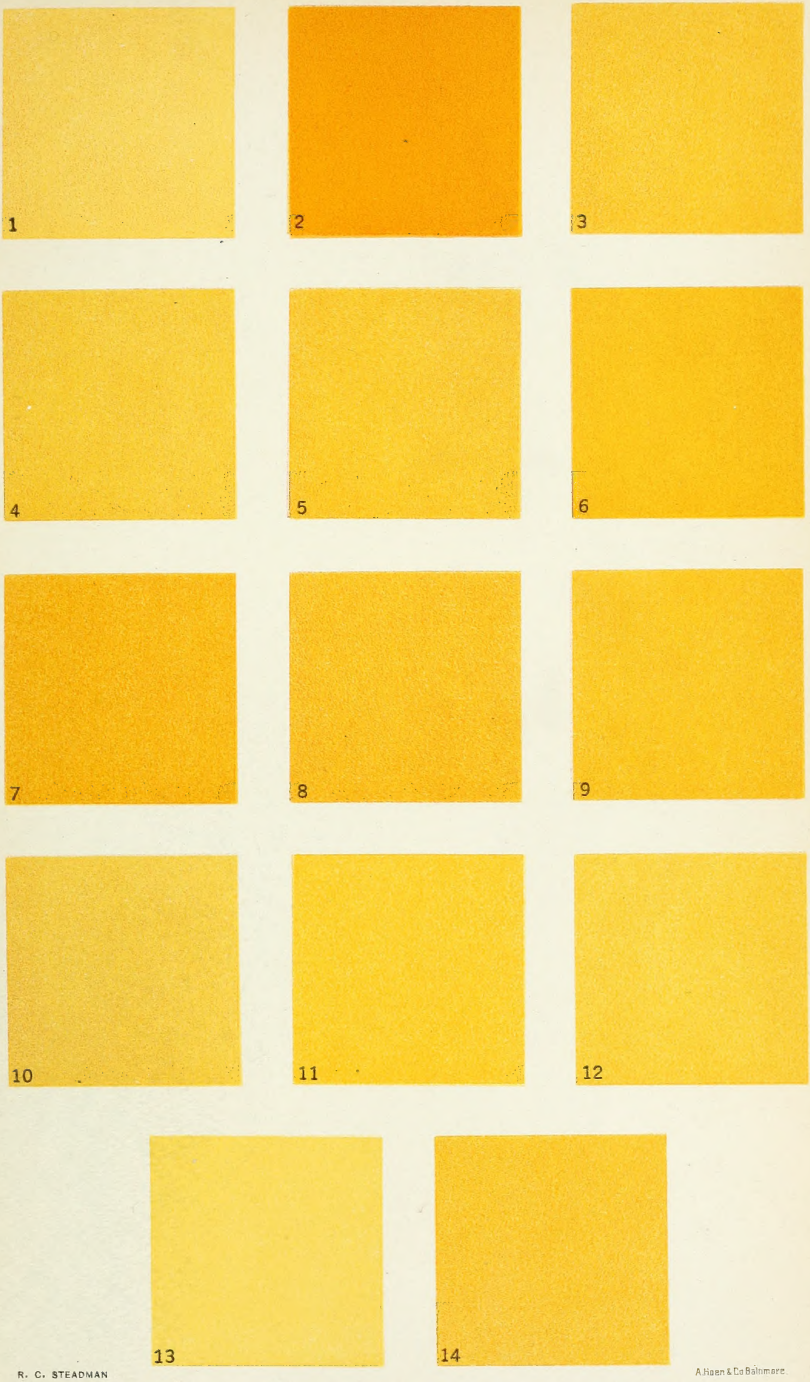
SHADES OF COLOR OF DIFFERENT VARIETIES OF SWEET POTATOES WHEN CANNED IN THE FORM OF PIE STOCK. I.

Explanation of figures: 1, Ballinger's Pride; 2, Belmont; 3, Big-Stem Jersey; 4, Catawba White; 5, Catawba Yellow; 6, Creola; 7, Dahomey; 8, Dooley; 9, Early Carolina; 10, Early Red Carolina; 11, Florida; 12, General Grant; 13, Golden Beauty; 14, Gold Skin; 15, Gros Grandia.



SHADES OF COLOR OF DIFFERENT VARIETIES OF SWEET POTATOES WHEN CANNED IN THE FORM OF PIE STOCK. II.

Explanation of figures: 1, Haiti; 2, Improved Big Stem; 3, Japanese "Yam"; 4, Key West; 5, Miles; 6, Mullihan; 7, Nancy Hall; 8, Pierson; 9, Porto Rico; 10, Pumpkin "Yam"; 11, Purple "Yam"; 12, Red Bermuda; 13, Red Brazil; 14, Red Jersey; 15, Southern Queen.



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SHADES OF COLOR OF DIFFERENT VARIETIES OF SWEET POTATOES WHEN CANNED IN THE FORM OF PIE STOCK. III.

Explanation of figures: 1, Triumph; 2, Vineless Pumpkin "Yam"; 3, Vineless "Yam"; 4, White "Yam"; 5, Yellow Jersey; 6, Yellow Strasburg; 7, Yellow "Yam"; 8, No. 10412; 9, No. 10650; 10, No. 11284; 11, No. 11285; 12, No. 12686; 13, No. 39833; 14, No. 49711.